RESEARCH REGARDING THE BIOLOGY OF SOME SPECIES OF THE *PELARGONIUM* GENUS CULTIVATED IN GREEN HOUSES OF THE BOTANICAL GARDENS IN IAŞI

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We took into consideration aspects regarding the biology of the two species belonging to *Pelarginium* genus: *P. zonale* (L.) L' Herit. and *P. odoratissimum* (L.) L' Herit. ex Ait., during their ontogenetic cycle in conditions of protected cultivation (greenhouse of temperate type). We also talked about aspects related to the morphology of secretory formations of volatile oils and about some special biochemical and physiological parameters. The researches of vegetal morphology and physiology have used classical methods of investigation and the volatile oil was extracted by steam distillation using a modified Clevenger apparatus, whereas the chemical composition was analyzed by GC – MS. The secretory formations of the volatile oils are characteristic for each taxon. The biochemical and physiological parameters investigated vary depending on the studied taxon and the ontogenetic moment. The efficiency of extraction of volatile oils has different values depending on the species and the ontogenetic stage of producing plant; the composition of the volatile oils differs in quantity and quality, giving specific aromatic characteristics to the analyzed samples.

Key words: P. zonale, *P. odoratissimum*, ontogenesis periods, parameters' dynamics, volatile oils, chemical composition.

INTRODUCTION

Geranium, species of the *Pelargonium* genus – *Geraniaceae family*, belongs to the group of rustic species used at interior decorations, balconies, windows and gardens. Because of its abundant and beautiful foliage, its continuous blossom, the representatives of the kind are very popular flowers, loved and widely cultivated.

Native from South Africa (Cape of Good Hope) the geranium becomes known in Europe at the end of the XVIIIth century, its culture spreading rapidly all around the continent; towards the end of the XVIIIth century, taxa of the *Pelargonium* genus get to Australia and the United States of America, becoming more and more popular in California where the climate was and is still propitious to its breeding. This led to an exponential growth of the number of new sorts. At present, 250–300 cultivated species belonging to *Pelargonium* genus are known all over the world (Şerbănescu, 1958; Gostin *et al.*, 2000). Nowadays we encounter the mass production of certain kinds in such a manner that limits the selection and production to some botanical gardens (Clifton, 1945).

The choice of the species of the *Pelargonium* genus as object for the present research is motivated by their ornamental and smelling qualities especially of the leaves (Vidraşcu, 1999), and by their potential use as source for substances in aromatherapy. We already know the composition of the volatile oil extracted from *P. citronellum* leaves (Demarne and Van der Walt, 1993) and of the oil obtained from *P. graveolens* (Fang *et al.*, 1989) (cf. Burzo *et al.*, 2005).

In this context, we must state the fact that a lot of research is taking place in our country on the same coordinate: cultivation of some imported taxa which produce volatile oils (in the Botanical Gardens in Iaşi), extraction of some secretion products, and analysis of their chemical composition and testing of their possible antimicrobial properties; we remind here the recent efforts of the staff of teachers and researchers from the University of Agronomical Science and Veterinarian Medicine of Bucharest, Faculty of Horticulture.

MATERIAL AND RESEARCH METHODS

Our research has had as object of study the following species: *Pelargonium zonale* (L.) L' Herit., plant with a medium height of 40–60 cm, steam with thick lateral ramifications pubescent and slightly lignified at the bottom (Şerbănescu, 1958) and *Pelargonium odoratissimum* (L.) L' Herit. ex Ait., with a medium height of 30–40 cm; both species are widely cultivated in protected areas of Romania.

Cultivated in protected spaces (green houses) *Pelargonium zonale* lives for several years with continuous vegetation and blossom, maintaining its leaves during the winter too; it can face direct exposure to sunlight and best tolerates an ambient temperature of 5–10°C as *Pelargonium odoratissimum*. Both species hate excess of moisture and prefer dry and ventilated places; they vegetate well in light soils and heavy ones if they are dry and rich in humus but with an acid pH; *Pelargonium odoratissimum* tolerates diffuse light (Sonea *et al.*, 1979).

The plants used in the research have been cultivated in the "Anastasie Fătu" Botanical Gardens in Iaşi, between June 2004 and March 2005; the experimental group of plants consisted of 40 individuals belonging to each of the two studied taxa.

Breeding of the biological material was made through cuttings of the stem (cutting in green); the stem fragments were taken from healthy mature plants and had a length of 2–6 internodes which were planted in a layer consisting of 1.5–2 parts of soil for leaves, 1 part of ground peat and 0.25 soil for garden; the depth used was of 3–4 cm.

The growth of the routes at 18–20 °C lasted 15 days for *Pelargonium zonale* and 20 days for *Pelarginium odoratissimum*. The maintenance of the cultures was done through current operations, without any chemical fertilization.

After planting the cuttings we have observed the ontogenetic evolution of the plants bred by a vegetative method, harvesting an amount of 15 mature healthy leaves. The harvest of the material started when the routed cuttings had each 4–5 normally developed leaves (Sonea *et al.*, 1979).

The tests were done during the whole ontogenetic cycle of the analyzed species, catching the vegetative period, the period before the flowering period and the actual flowering period related to the rhythm of the ontogenetic development of the individuals from the investigated lots.

Pointing out the secretory structures was done in the Anatomy and Vegetal Morphology Laboratory of the Faculty of Biology, "A.I.Cuza" University, Iaşi; we have used photographs of the surface of fresh foliar limb with NOVEX microscope at × 200. The microscopic images of the secretory structures which produce volatile oils were analyzed and graphically processed by a MINOLTA analogical photographic camera.

The biochemical and physiological analysis was done in the Vegetal Physiology Laboratory of the Faculty of Biology, "A.I.Cuza" University, Iaşi and in The Research Basis with Multiple Users of the Faculty of Horticulture, Agriculture Sciences and Veterinary Medicine Bucharest.

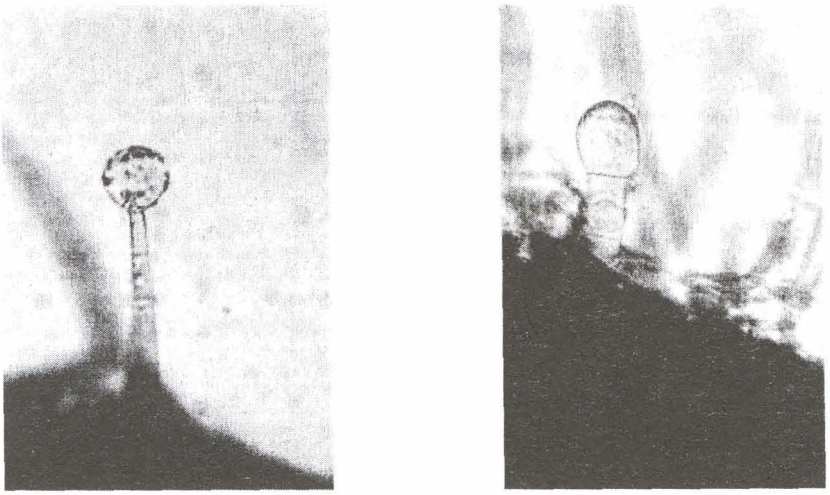
The following steps were necessary:

- Determinations on fresh material of the water and dry matter content – through the gravimetric method (Boldor *et al.*, 1983), of foliar assimilatory pigments – through the spectrophotometric method (Boldor *et al.*, 1983), of the intensity of the respiratory process – through the Warburg manometric method (Boldor *et al.*, 1983), of foliar glucoses content – through the Bertrand method (Artenie and Tănase, 1981) for extraction and Borel spectrophotometric method for dosage of foliar crude lipids – through the Soxhlet method (modified Artenie and Tănase, 1981).
- Determinations on dry material of foliar crude protein content – through the Kjeldahl method (Artenie and Tănase, 1981).
- The volatile oils were extracted from fresh leaves using a hydro-distillation method and a Clevenger device (the extraction was done during an approximately three-hour interval on a 1:3 vegetal material/ water proportion); the analysis of the quality of the oil took place in the Plant Physiology Laboratory of the Faculty of Horticulture, Bucharest using a GC gas chromatograph Agilant 6890N with a spectrometric mass detector 5973 and an auto sampler; the DB5 chromatographic column has a length of 25m and an interior diameter of 0.25 m.

RESULTS AND DISCUSSIONS

THE SECRETORY FORMATIONS OF VOLATILE OILS (Figure 1)

The analysis of the foliar surface points out for both species the existence of multi cellular glandular hairs on the two sides of the limb; these glands have big dimensions comparing to the component cells of the multi cellular leg at *Pelargonium zonale* and small ones at *Pelargonium odoratissimum*. The basis of the hair is situated between the epidermic cells, unicellular and polygonal.



a b

Fig. 1. Glandular hairs at *Pelargonium zonale* (a) and at *Pelargonium odoratissimum* (b) in the vegetative stage (× 200).

The leg is multi cellular and uniseriate (rectangular cells longer at *P. zonale* and shorter at *P. odoratissimum*), put one on top of another; as a consequence of that, the length of the secretory hair is variable. The aspect that was not pointed out during the ontogeny of the two analyzed species was the morphologic differences of the secretory hairs induced by the age of the leaves.

CONTENT OF DRY MATTER (Tables 1, 2)

At *Pelargonium zonale* species once the ontogenetic cycle is closed, we registered a slight tendency to reduce the content of dry foliar substance during our first three harvests (12.82 g% at the first harvest – during the vegetative period – and 11.32 g% at the third – during the beginning of blossom). Towards the end of

the ontogenetic cycle (the blossom period – harvests 5 and 6) this biochemical parameter registers a clear growth (14.05 g%, respectively 13.94 g%).

For *Pelargonium odoratissimum* we could observe a similar behavior, a quantitative variation of the studied parameter; a slight decrease during the first moments of analysis (20.62 g% for the harvest number 1, respectively 14.81g% at the harvest no. 3), moments in which our plants were passing through an extended vegetative period due to the low temperatures in the cultivation space (the greenhouse) and to a lower illumination during winter, when days are shorter and nights longer, conditions which do not allow the plants to sustain the photosynthesis process at its normal values. This has as a consequence the obvious accumulation of metabolism products, as constitutive parts of the dry foliar matter. Because of this, we consider that the process of biosynthesis and accumulation of dry foliar matter at this taxon is almost the same in the following analysis moment (harvest no. 4), still manifesting a tendency of reduction during the next harvest (harvest no. 5 from February) when this parameter reaches the absolute minimum value. Only at the last moment of analysis (harvest no. 6 from March when plants are in blossom period) the obtained value for the content of dry foliar matter grows, getting close to the values from December-January.

Comparing these two taxa depending on the quantitative variation of the content of dry matter, we note a tendency of superiority in numbers at *Pelargonium odoratissimum* species, kept during all the ontogenetic cycle.

WATER CONTENT (Tables 1, 2)

For both analyzed taxa, the biochemical and physiologic parameter does not lower spectacularly once the life cycle is closed, allowing through its values (over 79 g%) a good hydration of the foliar tissues and, consequently, their appropriate function (Burzo *et al.*, 2004).

At *Pelargonium zonale* the water content is slightly higher at the first moment of analysis (harvest 1–3, when plants are in the vegetative growth period and even in the blossom period), then decreases during the next 2 determinations (harvest 4–5 – January, February – when plants keep their capacity of vegetative growth and flowering) and register then a new growing tendency (harvest 6 – March) at blossom.

At *Pelargonium odoratissimum* the water content tends to grow all along the ontogenetic cycle, reaching the absolute minimum value at the first moment of analysis – 79 g% and then slightly grows toward an approximate value of 85 g% during harvest no. 2–4 or even 86 g% at the fifth harvest from February, all the plants being in a period of extended vegetative growth. At the last moment of analysis, when the analyzed plants get to blossom (harvest 6 – March), this parameter slightly tends to diminish, but not considerably (reaching approximately 85.8 g%) still insuring a good hydration of the foliar tissues.

CONTENT OF ASSIMILATING PIGMENTS (Tables 1, 2)

The content of "a" chlorophyll, pigment with a leading role in capturing and fixing the solar energy necessary for the photosynthesis process varies in quantity depending on the species (taxon) studied and on the moment of the ontogenetic cycle (Burzo *et al.*, 2004).

For *Pelargonium zonale* species, the "a" chlorophyll registers a constant decrease during the first 4 moments of analysis (October–January) when plants are in the vegetative growth period and later in the flowering period (0.4314 mg/g fresh vegetal tissue in the first harvest, 0.2257 mg in the fourth harvest). In February, when the analyzed plants are going through the flowering period, the chlorophyll comes back spectacularly, registering triple values compared to the previous ones; during this stage it can reach the absolute maximum value of 0.7903 mg. Next, at the last moment of analysis, (harvest no. 6 from March) the quantity of this pigment diminishes down to the lowest absolute value of 0.1077 mg.

At *Pelargonium odoratissimum* the content of "a" chlorophyll varies from one determination to another, showing alternative tendencies of altering in pairs of determinations (1 and 2, 3 and 4, 5 and 6). In this entire interval, "a" chlorophyll will still reach the absolute maximum value (0.7262 mg) in February, perfect timing with the longer period of sunlight (the day starts to grow).

The content of "b" chlorophyll, pigment with a special role in capture of the solar energy which it immediately transmits to the main fixation pigment – "a" chlorophyll – varies in quantities compared to the latter.

At *Pelargonium zonale* the quantity of "b" chlorophyll is superior to the quantity of "a" chlorophyll during the whole ontogenetic cycle, with only one exception (harvest no. 5 in February) when it becomes inferior.

All along the determinations, this type of assimilatory pigment manifests, as "a" chlorophyll, a rhythmical variation in quantity, on groups taken two by two (harvests 1 and 2, 3 and 4, 5 and 6) with the difference that at the first two groups of determination the registered differences are going up and for determinations 5 and 6 are going down.

For *Pelargonium odoratissimum* the "b" chlorophyll exceeds in general the quantity of "a" chlorophyll with only one exception: December (the third moment of analysis) when in the plants' leaves the "a" chlorophyll prevails. Under these circumstances, for the species we refer to and unlike the species we have studied earlier – *P. zonale*, the dynamics of the biosynthesis and of "b" chlorophyll accumulation in the foliar assimilatory tissue registers decreasing values for determinations 1 and 2, 5 and 6 and increasing ones for determinations 3 and 4.

Because at both studied species we note that the "b" chlorophyll prevails in quantity as compared to the "a" chlorophyll the proportion between them is in almost all moments of investigation under 1, even during determination no. 5 from February done on *P. zonale*, when it becomes bigger than 1 but still does not reach the value stated by the science literature: 3/1 in favor for "a" chlorophyll. We

consider then those both analyzed species, native from countries very warm and with very much sunlight, behave differently in the conditions provided by the temperate greenhouse of the Botanical Gardens in Iaşi where the analysis took place.

The carotenoidic pigments have not such an important role in capturing the solar energy and giving it to the "a" chlorophyll, but protect them against the destructive action of the ultraviolet radiation from the solar spectrum. They also vary in quantity depending on the moment when the determination is done (Burzo *et al.*, 2004).

For *Pelargonium zonale* the content of carotenoidic pigments manifests a slight tendency to diminish during the winter months (approximately 0.2146 mg/g fresh vegetal tissue in October and then under 0.2 mg until January) and visibly increases in February (0. 2951 mg at harvest no. 5) and in March (0.3957 mg at harvest no. 6). This higher concentration of carotenoidic pigments in proportion with the illumination (the day becomes longer) can be related to the reactivation of the protecting function of these pigments, although the test plants have been cultivated in the greenhouse and the glass is an efficient shield against UV radiations.

For *Pelargonium odoratissimum*, the content of carotenoidic pigments is in most of the determinations inferior to the one registered to the previously analyzed species. It has an increasing tendency during the first determinations (0.1839 mg for the first harvest in October and 0.2175 mg for harvest no. 3 in December) followed by an immediate decrease in January and then, towards the end of the investigation period (February–March), by a visible growth explained by a similar judgment as presented earlier.

THE RESPIRATORY PROCESS (Tables 1. 2)

Analyzing the variation of the medium foliar respiration process on an interval of 30 minutes from the start of the determinations for the two taxa, we observe the following:

At *Pelargonium zonale* the respiratory process manifests a slight tendency of decrease during the first months of analysis (0.105 cm^3 O_2 consumed/g fresh vegetal material/hour in harvest from October, respectively 0.067 cm^3 in December at harvest no. 3). During these first moments of analysis the test plants have passed through the vegetative growth period and have entered the second vital period of their cycle, the flowering stage. Later, the respiration process increases and its dynamic curve has an ascendant slope from the fourth harvest (0.083 cm^3 O_2) until the end of the study period (harvest no. 6), when we confront an absolute maximum value of 0.138 cm^3 O_2).

At the *Pelargonium odoratissimum* species, the dynamics of the foliar respiration process initially registers, as in the case of the previously studied taxon,

a slightly descendent slope during the first three determinations (0.106 cm^3 O_2 for the first harvest and 0.085 cm^3 O_2 at harvest no. 3) followed by an ascendant one during the next moments; consequently, at the final harvest the value is the absolute maximum of this process (0.146 cm^3 O_2).

Comparing the curves of the foliar respiration process of the two taxa, we note an obvious resemblance according to the moment of analysis, which leads us to the conclusion that both species have a high consume of energy in the second part of the ontogenetic cycle (January–March); in this period, the conditions of the environment get better: the period of lighting is longer and this correlated with the greenhouse effect lead to a slight rise of the ambient temperature. As a consequence to that, an intensification of growth and development processes is induced; these processes are great consumers of metabolic energy and allow the development of vegetative mass and blossom.

CONTENT OF GLUCOSES (Tables 1, 2)

Analyzing the content of foliar glucoses (total glucoses and separate on component forms), we have observed that this biochemical and physiological parameter obviously varies in quantity depending on the analyzed taxon and on the moment of the ontogenetic cycle (the moment of the harvests). Along the ontogenetic cycle of the two test species, we have found all glucoses forms using the applied method of analysis: monosaccharides, disaccharides, soluble and insoluble polysaccharides. These components vary in the leaves of the analyzed plants with an apparent drastic decrease of some of them (especially disaccharides, as a main form of traveling sugar inside the plants). In this situation, we consider useful the discussion about the total content of foliar sugars at these two species.

At *Pelargonium zonale* the total content of foliar glucoses has an obvious tendency to diminish during the first three moments of analysis (15972 mg glucose/100 g vegetal material dried in air at the first harvest in October and only 4989.13 mg of glucose at harvest no. 3 from December). This decrease corresponds to the moment when the plants pass from the vegetative growth period – harvest no. 1, to flowering – harvests 2 and 3; so, we can speak now of an important consumption of total glucoses in the test plants during the induced metabolic effort to realize the phenomena of flowering.

Later, the content of total glucoses grows considerably (6968.88 mg of glucoses at the fourth harvest from January) and reaches a similar value 7327.58 mg of glucoses at the final harvest , no. 6, from March), after a drop in February of 5737.58 mg of glucoses.

At *Pelargonium odoratissimum* this biochemical parameter has a constant and continuous tendency to grow (5199.25 mg of glucoses during the first harvest and 10778.11 mg of glucoses towards the end of the determinations).

From the comparative analysis of the foliar glucoses content at the two test species, we can consider that the *Pelargonium zonale* species has a biosynthesis

and accumulating process more fluctuant in contrast to *Pelargonium odoratissimum*. The evolution on the quantity of this biochemical parameter reflects the succession of the vegetative and the flowering period during the ontogenetic cycle.

CONTENT OF CRUDE LIPIDS (Tables 1, 2)

The content of foliar lipids varies at the analyzed species depending on which one of them is under discussion and on the exact moment of study (Burzo *et al.*, 2004).

For both test species we observe similar curves of biosynthesis and accumulation of foliar lipids, with big variations during the ontogenetic cycle.

Also, for both species, we register initially a high content of foliar lipids (11.07 g / 100 g vegetal material dried in air for *Pelargonium zonale*, respectively 13.76 g for *Pelargonium odoratissimum* at the first moment of analysis), a decreasing tendency at the second harvest followed by an obvious correction towards the middle of the investigation period (harvests 3 and 4) and at its end, both species present a lipid content almost equal to the one from the beginning of the analysis (12.33 g for *Pelargonium zonale*, respectively 11.07 g for *Pelargonium odoratissimum* at harvest no. 6).

We conclude that this big variation of the investigated parameter can be explained by the different consumption of metabolic energy done by test plants when passing from one stage of the ontogenetic cycle to another, consume that insures the normal vital processes during the growth and blossom.

THE CONTENT OF CRUDE PROTEIN (Tables 1, 2)

The content of crude protein varies a lot from one moment of analysis to another, realizing specific curves for each of the taxons analyzed.

For *Pelargonium zonale* the maximum value is registered at the beginning of the ontogenetic cycle (harvest 1–7.37 g crude protein/100 g vegetal material dried in air). This value indicates a good functional structure of the foliar apparatus (proteins as support with multiple functions) with a great metabolic power of synthesis, characteristic during the vegetative growth period (stage of youth of test plants). The situation appears again at the fourth moment of analysis, when plants are still going through the vegetative growing period, after blossom of the first series of flowers (so the vegetative apparatus is regenerating); but now the values are smaller as compared to the first harvest (4.52 g). During the flowering period this parameter drops considerably, the situation revealing a migration of the components towards the reproductive apparatus, where they actively intervene in building of floral pieces and of reproductive elements.

Table 1

Variation of some biochemical and physiologic indices at *Pelargonium zonale* (L.) L' Hérit., during one ontogenetic cycle

Date of harvesting the material	The harvest / The ontogenetic stage	The dry matter content g%	The water content g%	The content of "a" chlorophyll mg/g fresh material	The content of "b" chlorophyll mg/g fresh material	The content of carotenoidic pigments mg/g fresh material	Total glucoses mg gluc/100 g material dried in air	Lipids mg /100 g material dried in air	Proteins mg /100 g material dried in air	Respiratory process $cm^3 O_2$ /g fresh material / hour
21.10.2004	Harvest. 1 – Vegetative stage	12.82	87.18	0.4314	1.1486	0.2146	15972	11.07	7.37	0.105
17.11.2004	Harvest. 2 – Vegetative stage	12.21	87.78	0.3175	0.9123	0.1374	8436.35	2.48	1.75	0.078
8.12.2004	Harvest. 3 – Vegetative stage	11.32	88.67	0.254	1.7226	0.1771	4989.13	6.82	2.45	0.067
13.01.2005	Harvest. 4 – Vegetative stage	10.39	89.61	0.2257	1.0799	0.1361	6968.88	7.41	4.52	0.083
15.02.2005	Harvest. 5 – Vegetative stage	13.78	86.22	0.7903	0.6344	0.3206	5737.58	5.46	0.37	0.115
23.03.2005	Harvest. 6 – Vegetative stage	13.94	86.06	0.1077	0.7171	0.3957	7327.58	12.33	0.82	0.138

Table 2

Variation of some biochemical and physiologic indices at *Pelargonium odoratissimum* (L.) L' Hérit. ex Ait., during one ontogenetic cycle

Date of harvesting the material	The harvest / The ontogenetic stage	The dry matter content g%	The water content g%	The content of "a" chlorophyll mg/g fresh material	The content of "b" chlorophyll mg/g fresh material	The content of carotenoid c pigments mg/g fresh material	Total glucoses mg gluc/100 g material dried in air	Lipids mg /100 g material dried in air	Proteins mg /100 g material dried in air	Respiratory process $cm^3 O_2$ /g fresh material / hour
21.10.2004	Harvest. 1 – Vegetative stage	20.62	79.38	0.287	1.3508	0.1839	5199.25	13.76	0.66	0.106
17.11.2004	Harvest. 2 – Vegetative stage	15.40	85.6	0.1927	1.1494	0.1900	5961.47	2.83	0.87	0.094
8.12.2004	Harvest. 3 – Vegetative stage	14.81	85.19	0.4781	0.3328	0.2175	8172.67	5.87	0.73	0.085
13.01.2005	Harvest. 4 – Vegetative stage	14.92	85.08	0.3074	1.3993	0.1716	6988.38	6.04	5.85	0.090
15.02.2005	Harvest. 5 – Vegetative stage	13.78	86.22	0.7262	1.5968	0.4092	11467.51	5.35	5.14	0.110
23.03.2005	Harvest. 6 – Vegetative stage	14.20	85.80	0.1095	0.8179	0.3831	10778.11	11.07	1.53	0.146

At *Pelargonium odoratissimum*, the quantity variation of this biochemical and functional parameter is done at a lower level (all the values registered do not exceed 5.85 g).

We consider that this reality can be related to the progressive development of the individuals belonging to the same species from the vegetative growth stage to reproduction (flowering); this is the reason why the enhancement of biosynthesis process of nitrogen compounds (special proteins) implicated in the function and structural consolidation of the foliar apparatus is less spectacular.

CHEMICAL COMPOSITION OF VOLATILE OILS (Diagram 1)

The comparative analysis of the composition of volatile oils extracted from the leaves of the analyzed species point out a qualitative difference depending on the moment chosen (related to a certain ontogenetic stage).

So, if for *Pelargonium zonale* in the vegetative stage 49 components were separated, in the flowering stage the synthesis of volatile oils reaches an absolute maximum of quality, the number of components being 4 times bigger (161).

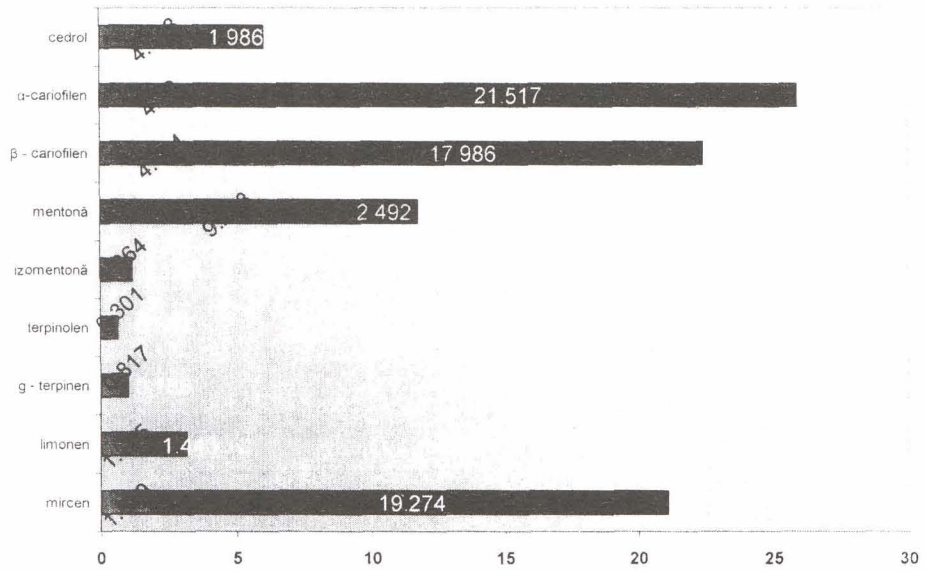


Diagram 1. Comparative chart for the main components of *Pelargonium zonale* volatile oils extracted (% concentrations) before flowering period (green color) and during flowering period (red color).

The component fractions of the volatile oils separated into 2 moments of analysis vary substantially, the prevalence of one or another indicating specific aromatic characteristics for the analyzed samples.

CONCLUSIONS

• *The content of dry foliar matter* accumulated all along the ontogenetic cycle at *P. odoratissimum* manifests a tendency of superiority over the one at *P. zonale,* and *the water content* does not drop spectacularly once the cycle is closed at both taxa, allowing, through its values, a good hydration of the foliar tissues and consequently their good function.

• *The content of "a" and "b" chlorophyll* manifests rhythmical variations in quantity for both analyzed taxa, with the observation that the later prevails. *The carotenoidic pigments* vary also depending on the species and on the moment of determination.

• Both species achieve a *notable energetic consumption* during the second part of the ontogenetic cycle, when an intensification of growth and development processes, two processes that need a lot of energy; this reality explains the intensification of the *respiration process* at that particular moment.

• The *content of foliar glucoses* obviously varies in quantity depending on the analyzed species and the moment of the ontogenetic cycle; in this context, *P. zonale* species achieves a much more fluctuant process of biosynthesis than the one of *P. odoratissimum.*

• At both species we noticed a big variation of the *crude foliar lipids* as an energetic support for the specific energy used by the two taxa when passing from one stage of the ontogenetic cycle to another.

• *The content of crude protein* varies substantially, achieving specific curves for each species. *P. zonale* registers the highest values in the period of vegetative growth, and then it decreases in the flowering stage. At *P. odoratissimum* the variations in quantity of the content of raw protein are much smaller.

• The efficiency of extraction of essential oils has different values depending on the species and on the ontogenetic stage the producing plant is in. The composition of volatile oils in the two stages of the ontogenetic cycle differs in quantity and quality and develops specific aromatic characteristics.

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